

Question 1:

Three long plates made of steel, aluminium and titanium respectively are each subjected to tensile loading of 500 kN (the cross sectional area of each plate is 0.0005 m^2). In the technique used for manufacturing of the plate, the maximum flaw size can only be limited to 700 micrometres. Select materials from the list below that are not likely to fail by fast fracture under the applied load and justify your answer.

Assume the parameter Y to be 1.

The data of the materials are provided below.

<i>Material</i>	<i>Yield Strength</i>		<i>K_{Ic}</i>	
	<i>MPa</i>	<i>ksi</i>	<i>MPa√m</i>	<i>ksi√in.</i>
Aluminum alloy ^a (2024-T3)	345	50	44	40
Titanium alloy ^a (Ti-6Al-4V)	910	132	55	50
Alloy steel ^a (4340 tempered @ 260°C)	1640	238	50.0	45.8

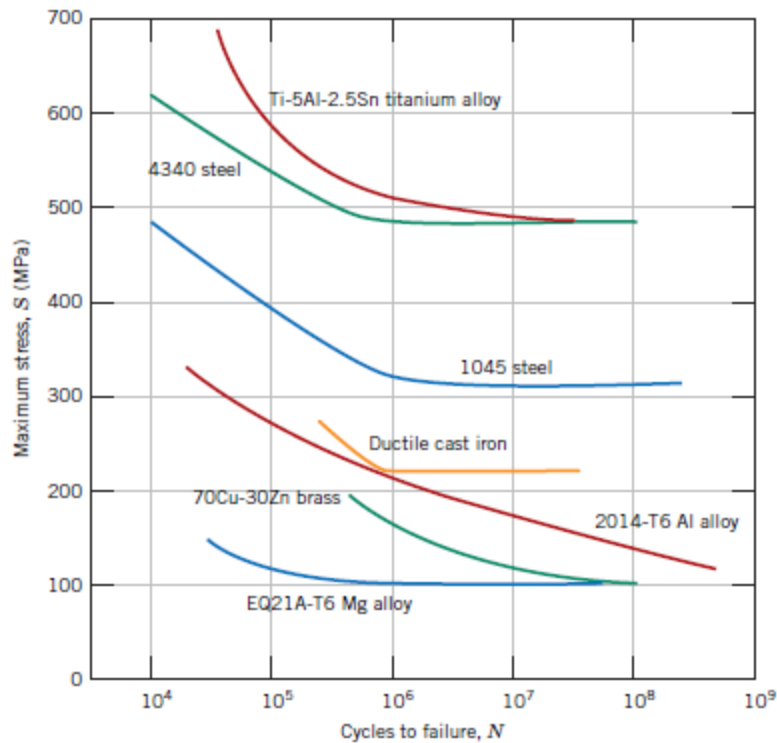
Question 2:

A cylindrical bar of 20 mm diameter is subjected to cyclic loading with a maximum load of 1200 N in a rotating-bending test. Assume a factor of safety of 4.0 and that the distance between loadbearing points is 100 mm. (a) Suggest suitable material(s) from the graph so that the cylindrical bar will not undergo fatigue failure under the given load and conditions.

The S-N curve data of the materials are shown in the figure below.

Consider a safety factor of 4 for all the beams.

- (b) What is the percentage increase in the maximum load limit of the EQ21A- T6 Mg alloy cylindrical bar if the diameter is increased to 25 mm?
- (c) Explain the difference between steel and aluminum in terms of fatigue behavior?



Question 3:

(a) Determine the longitudinal and transverse Young's Modulus, and Poisson's ratio for graphite-epoxy lamina containing 50% volume of fibers.

Consider the following mechanical properties of the composite.

$$E_f = 230 \text{ GPa} \quad E_m = 3.5 \text{ GPa}, \quad \nu_f = 0.2 \quad \nu_m = 0.3.$$

(b) Explain the role of fibre and matrix in a composite material.

Question 4:

- What is shot peening? What is the purpose of using this process?
- Briefly explain why BCC and HCP metal alloys may experience a ductile-to-brittle transition with decreasing temperature, whereas FCC alloys do not experience such a transition.
- List four measures that may be taken to increase the resistance to fatigue of a metal alloy.
- Explain the difference between fatigue striations and beachmarks also mention the similarities between the two.